U.S. Department of Agriculture • Science and Education Administration
July 1981

Agricultural Research

Germplasm for America's Future

If Americans were asked to live on food from native crops, we would be shocked by our limited diet—sunflower seeds, cranberries, blueberries, strawberries, pecans, and not much else. Cereals, potatoes, most fruits, and vegetables would be missing. We would have no cotton or flax for clothing and textiles. Our payments for importing food and fiber would make our payments for oil seem small.

In precolonial and colonial days, the early settlers in this country found no familiar crops from the Old World. Word was sent back that later immigrants should bring seed with them since the Indians grew only some corn, beans, and squash, also brought into the country ages ago by tribes from what is now Mexico.

The government realized early the lack of native food crops and encouraged the search abroad for seed of adaptable crops. In the early 19th century, American consuls stationed overseas collected seed of useful plants and sent them home.

After the U.S. Department of Agriculture was established in 1862, plant exploration and introduction expanded greatly. Some collected plants became new crops, some were used for breeding better varieties than those being grown, and many were abandoned or lost. Individual plant breeders sometimes were able to maintain a few varieties and over the years USDA established maintenance facilities in this country for these collections.

Throughout recorded history, people cultivated and saved superior plants. Over the centuries, chance or man-made hybrids, called "folk" varieties, were developed in all parts of the world. Great genetic variability existed within and among these varieties. And wild relatives of these cultivated varieties generally survived in nature. During those years, the pressures of population explosion and advanced agricultural technology had not yet destroyed their natural habitats. Today our genetic resources—the wild plants and the "folk" varieties—are being lost at a rapid pace with the destruction of natural habitats and changing land-use patterns.

After the "folk" varieties, professional plant breeding began—only about 60 or 70 years ago. Since then, a constant stream of highly uniform modern crop varieties has been fed into the agricultural system which resulted in remarkable increases in productivity. The superiority of these modern varieties over "folk" varieties led to their wide adoption, thereby giving us the most productive agricultural system in the world.

Why must we continue to import new varieties of plants? The answer lies behind the scenes in two scientific concepts—"genetic uniformity" and "genetic vulnerability."

Because our crops today are more genetically uniform, they are more genetically vulnerable as new and more virulent forms of crop disease evolve naturally. When only a few, but highly productive crop varieties are grown, huge losses can result when these few varieties become susceptible to disease.

An example of this occurred in 1970 when the fungus causing southern corn leaf blight swept across the country and shocked the agricultural community. Losses in some states were as high as 50 percent. National losses of this major crop averaged about 15 percent. Corn crops for subsequent years were saved only because a variety of corn with genes resistant to this disease was available to breeders. This near disaster represents a classic case of genetic vulnerability.

With the genetic uniformity of many of our food crops and the fact that these crops, now so common to us, originally were immigrants to this country, the necessity and urgency of collecting and preserving the older "folk" and wild varieties with more genetic variability from around the world became apparent.

Toward this end, the National Plant Germplasm System (NPGS) evolved over time in USDA's Agricultural Research Service to combat the genetic vulnerability of our crops. Germplasm is the name scientists use for the hereditary materials used in breeding. NPGS is establishing a network of 11 germplasm repositories across the United States and Puerto Rico to include this valuable genetic material (see article on page 10).

Today the system contains over 450,000 samples with about 7,500 new introductions being added annually. Not only does NPGS acquire germplasm, but it maintains, evaluates, and distributes it to professional plant breeders and other scientists.

Efforts are now underway to develop an international germplasm network with the International Board for Plant Genetic Resources located in the Food and Agriculture Organization of the United Nations and supported by that organization and by the Consultative Group for International Agricultural Research. Highly respected international agricultural research centers are assuming responsibility for germplasm collections of important food crops. National germplasm programs, such as NPGS, and those in the USSR, Japan, and Brazil will increase their genetic resources as part of the international network.

Only with the dedication of agricultural scientists in this country and others throughout the world and adequate financial support, can these valuable genetic resources be saved to insure our future food supply.

It has been said that the time is not too distant when the essential genetic resources of all our major crops will be found only in the crops growing in our fields or in gene banks.

Contents

Agricultural Research
Vol. 30 No. 1
July 1981

Editor: Patricia Loudon
Associate Editor: Virginia Dryden
Photography Editor: Robert C. Bjork
Art Director: Deborah Shelton

Agricultural Research is published monthly by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, D.C. 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 15, 1982. Yearly subscription rate is $13 in the United States and its territories, $16.25 elsewhere. Single copies are $1.25 domestic, $1.60 foreign. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by photo number.

Magazine inquiries should be addressed to: The Editor, Information Staff, Room 3147-S, USDA, Washington, D.C. 20250. Telephone: (202) 447-6133.

Cover: Fruit and nut tree graft unions can be formed in 3 to 4 weeks with this hot-callusing pipe, a new device designed by an ARS horticulturalist in Corvallis, Ore. The pipe directs heat at the graft union, accelerating callus tissue formation without causing dormant plants to break bud prematurely. Filbert grafts here are callused, and plants are ready to be placed in nursery or cold storage. Our story begins on page 12 (0381X317-32).

Northeast Emphasizes Horticultural Crop Research

Above: Part of major ARS effort to help northeastern family farmers compete in the marketplace, ARS researchers in Beltsville, Md., cooperating with the University of Maryland, have developed a new trellis system that will simplify pruning of thornless blackberries. Gene Galletta, ARS research geneticist at Beltsville's Fruit Lab, and Howard Kerr, coordinator of small farms research for ARS, Northeastern Region, examine new growth, which was trained to grow up nght side of trellis. Last season's fruiting canes, now pruned away, were trained to grow up left side (1080A1347-16a).

It now costs about $2 to ship 24 cans of processed tomatoes from California to the Northeast. And northeastern shoppers are paying an average of 15 cents in transportation costs for each head of California lettuce. "In the future, the cost of fuel will increasingly dictate which crops are grown where," says Allan K. Stoner, one of the many scientists involved in a major ARS research effort to help the family farmer compete in the market.

To plan how research funds from this region would be spent, Howard "Bud" Kerr, coordinator of small farms research in the Northeastern Region, surveyed Extension agents in 70 counties. These agents answered a questionaire aimed at characterizing the farm picture in each state and identifying the current and future needs for farm research for the region as a whole.

Vegetable crops rank first among commodities produced on northeastern family farms. Tomatoes and sweet corn are leading cash crops followed by green beans, melons, and cucumbers. When asked to identify specific research needs for horticultural farms, the Extension agents most frequently mentioned improved production. They emphasized the need for new vegetable varieties that mature earlier, grow in cooler temperatures, are more tolerant to stress, and have better flavor and eye appeal for the fresh market. The agents see a need for research on growing vegetable transplants locally and on intensive production systems that would allow several crops to be grown on the same parcel of land each season.

For fruit and berry producers, the respondents emphasized the need for better tasting, more attractive varieties and for cultural methods that require less labor. The following describes some of the research projects being carried out to meet these needs.

VEGETABLE RESEARCH

One method of increasing production on the family farm is to stretch the growing season. By starting with a cool-season crop in the spring, switching to a hot-weather crop in the summer, then back to a cool-season crop in the fall, a farmer could keep the same parcel of

land in production for 6 months of the year.

Stoner, a horticulturist with the Vegetable Laboratory at Beltsville, Md., is developing cultural techniques for two types of succession plantings, cauliflower-tomatoes-cauliflower and strawberries-squash-strawberries. The study includes selecting varieties that have better taste and eye appeal and determining combinations of manure or compost, type of irrigation, and type of mulch that produces high yield and early maturity.

Many of the vegetables grown in the Northeast are started in Georgia from seed, which makes northeastern farmers dependent both on Georgia weather and on a limited number of varieties. ARS horticulturist Franklin D. Schales and coworkers at the University of Maryland Vegetable Research Farm in Salisbury, Md., are experimenting to make greenhouse-grown transplants competitive with field-grown transplants from the South.

"By growing their own transplants, farmers could have the varieties they

Opposite page: Patricia Millner, microbiologist in Beltsville, sees how lettuce grown in a composted sludge-based medium measures up. Beltsville researchers are studying compost's effectiveness in controlling plant disease (1180A1397-11a).

Top: By integrating various weed control methods, farmers can improve herbicide effectiveness. John Teasdale, plant physiologist at Beltsville's Weed Science Lab, performs spot application of a contact herbicide in test plot as part of evaluation of weed control systems (0780A806-17a).

Right: One way farmers can increase production on their family farms is to stretch the growing season. At Beltsville's Vegetable Lab, researchers are comparing the effectiveness of different mulches and other systems in protecting crops from low temperatures (1080A1348-8a).

Above: Many northeastern farmers are dependent on field-grown transplants from the South, but could benefit by growing their own. At the Maryland Vegetable Research Farm, Salisbury, Franklin Schales, ARS horticulturist, and Joanna Goeckeritz, research technician, test various potting media that could help make greenhouse-grown vegetable transplants competitive with southern field-grown plants (0680W684-20a).

Above: The Colorado potato beetle isn't finicky—he'll eat tomatoes, too. Because the beetle has become resistant to several insecticides, researchers at the Vegetable Lab are studying how much damage a tomato plant can sustain without significant yield reduction. This knowledge could help growers hold insecticide use to a minimum (0980A1085-3).

Top: William Cantelo, entomologist, left, and Kerr examine test plots where beetle damage has been simulated with different levels of defoliation (0980A1086-30).

want and have them ready for sale in the early market," says Schales. Transplants could also be sold to other farmers and gardeners to defray costs, and the greenhouses could be used for growing fresh produce at other times. The researchers are testing local materials such as pine bark and composted sewage sludge as potting media to replace more expensive, conventional potting materials.

In a similar study, research agronomist Rufus Chaney of the Biological Waste Management and Organic Resources Laboratory (BWMORL) at Beltsville and scientists from the University of Maryland tested 50 potting media for suitability in growing vegetable transplants.They found 10 mixes that produced as many healthy transplants as the standard peat-perlite mixes. Chaney now is determining the best fertilization rates and practices for growing a wide variety of transplants in composted sludge-based media.

Chaney evaluated the heavy metal levels in crops grown from transplants started in sludge-based media. Sludges that are acceptable for use on farmlands did not increase heavy-metal levels in the leaves of transplants or in field-grown crops. Levels in the edible tissue of cabbage, cantaloup, and tomato were very low.

Schales' research group is also screening standard and new varieties of cool-season vegetables for cold hardiness. The Maryland researchers are comparing the cost and economic advantage of several commercial products that protect crops against frost, such as row covers, plastic tunnels, hot tents, and hot caps. If these products prove economically feasible, farmers could extend the marketing season.

The acreage of good farmland, especially around metropolitan areas, has been shrinking at an alarming rate over the last decade. Land that is left commands a premium price. Two Beltsville scientists are interested in increasing farmland by upgrading poor soils with composted sewage sludge—a potentially cheap and abundant byproduct of cities.

Soil scientist Sharon Hornick (BWMORL) has completed her second season of growing vegetables on land that has been either strip-mined or out of production for many years. Both sites had soils that were acidic, ranging in pH

from 4.2 to 4.6, and had little or no organic matter.

She found that the composted sewage sludge, which contains about 10 percent lime, raised and maintained soil pH better than ground limestone did because of the buffering capacity of the organic compost.

Results from the first year of study showed substantially higher yields of sweet corn and snap beans planted in the composted strip-mined plots than of those planted in control plots that were limed and fertilized only. Snap bean yields from compost-treated plots that had previously stood fallow for years were also significantly higher than yields from the control plots.

Hornick studied three methods of mixing composted sludge into the soil—rototilling, plowing, and subsoiling. The largest increase in sweet corn yield came from plots where the compost had been incorporated into the soil to a depth of 18 inches with a subsoiling apparatus attached to the back of a tractor.

Disease Control

Composted sewage sludge has the potential to do more than fertilize, lime, and condition soil—it may also control plant diseases such as root rots and wilts.

Plant pathologist Robert D Lumsden and soil scientist Jack A Lewis of the Soilborne Diseases Laboratory have teamed with microbiologist Patricia Millner (BWMORL) to test the use of compost for controlling soilborne plant diseases.

Compost has its own microbial population, and some of its fungi and bacteria may compete with or feed on the soilborne pathogens, thus controlling disease on crop plants, explains Millner.

Greenhouse tests of beans, peas, melons, lettuce, and cotton showed that compost-soil mixtures controlled disease in several cases. But the scientists point out that the microbial population of composted sewage sludge (and thus its disease-reducing potential) can vary greatly depending on the source of sludge and the weather conditions. When composted sludge was tested on lettuce, cotton, and peas in the field, it significantly reduced two important

Above: Researchers at Beltsville's Applied Plant Pathology Lab are studying methods of curbing disease in lima beans. Vansie Blount, research technician, screens pole limas for disease and insect damage (0980A1088-20a).

Above: With fuel and shipping costs on the rise, family farmers in the Northeast will play an important role in supplying fruits and vegetables to consumers in their own region.

Farmers' markets, like the District of Columbia Open-Air Farmers' Market, provide these farmers with a direct market outlet to consumers (1080A1231-4).

diseases—lettuce drop and damping-off of peas and cotton.

Downy mildew causes serious losses in both fordhook and baby green lima beans. Anthracnose also cuts profits for growers of baby green limas. Plant pathologist Charles A. Thomas of Beltsville's Applied Plant Pathology Laboratory established plots of both types of limas. Last season he planted other cash crops (corn, edible soybeans, and snap beans) in the plots to determine which rotations would curb lima diseases in the third season. At that time Thomas plans to screen different lima varieties for disease resistance.

Insect Control

The Colorado potato beetle has become resistant to several insecticides—a fact that is causing concern among vegetable farmers, especially potato growers. The beetle also causes heavy economic losses in tomato, pepper, and eggplant crops. To hold insecticide use to a minimum and possibly delay the development of resistance to other insecticides, entomologist William Cantelo, with the Vegetable Laboratory at Beltsville, is determining how much leaf damage a tomato field can sustain without reduction in yield. First Cantelo measures how much a beetle larva eats. Then he strips leafs from tomato plants to test varying degrees of defoliation. By comparing yield from the defoliated plants with the feeding measurements, he should be able to estimate how many beetles could be tolerated before insecticides need to be applied.

Zoologist William R. Nickle is testing another means of curbing the Colorado potato beetle. The beetle was introduced into Europe where it was parasitized by a roundworm, says Nickle, who is with the Nematology Laboratory at Beltsville. He imported these parasites from Austria, where they kill up to 60 percent of the beetle population, to see if they could adapt to the soils and climate in this country and control the beetle without harming our beneficial insects.

Nickle introduced these parasites into tiny field plots (called microplots) to test their ability to overwinter. Last spring,

tomatoes were planted in the microplots and Colorado potato beetles as well as a beneficial insect (ladybird beetles) were released into cages that covered the plots. The Colorado potato beetles became infected. The ladybird beetles did not. These tests are being continued this year with earthworms and other beneficial insects.

Nematode Control

Biological control is being studied for two of the many species of roundworms that cause economic losses in the Northeast. The southern root-knot nematode is primarily a pest of vegetable, tobacco, and greenhouse crops and of soybeans grown in the sandy soils of Delaware and Maryland's Eastern Shore. The northern species attacks vegatables, perennials, and strawberries throughout the region.

Richard M. Sayre, a plant pathologist with Beltsville's Nematology Laboratory, is evaluating a bacterial parasite for control of both nematode species. "The bacterium, *Bacillus penetrans,* infects only a few plant-parasitic species," says Sayre.

Nematodes infected with this bacterium release spores that penetrate uninfected nematodes, and the cycle continues. Over seveal years the spore population is built up to a level that gives effective control of the nematodes. The spores are tolerant to some soil fumigants, can withstand dry soil condition, and persist in soil for months to years, explains Sayre. These characteristics should allow them to fit into an integrated pest management program.

Sayre has achieved some control of the southern root-knot nematode in greenhouse tests. Last summer he introduced the bacterium into microplots. He is evaluating the ability of the bacterium to control damage to tomatoes, cucumbers, and soybeans by the southern species and to strawberries by the northern species.

Weed Control

Plant physiologist John R. Teasdale, with the Weed Science Laboratory at Beltsville, is evaluating weed control systems.

Research over the past 2 years has shown that different control methods must be integrated for effective weed control in most horticultural crops. By combining preplant herbicides, cultivation, directed post-emergence herbicides, and hand-hoeing, the farmer can greatly improve the effectiveness of the herbicides and, at the same time, reduce the energy and labor required for cultivation and hand-hoeing. Black plastic mulch was most effective when used in combination with herbicices to control weeds on the bare ground between rows and within the planting holes.

Teasdale is screening several new herbicides for effectiveness and toxicity to crops, and for their persistence in the soil in double-cropping systems. Data from this research are expected to support the registration of a number of promising herbicides for use in growing blackberries, cabbage, cucumbers, peas, snap beans, sweet corn, and tomatoes, he says.

FRUIT RESEARCH

Under a cooperative agreement with the ARS Fruit Laboratory at Beltsville, Harry Swartz is working on the culture and management of strawberries and thornless blackberries at the University of Maryland, College Park.

In his work on thornless blackberries, Swartz developed a trellis shaped an inverted pyramid. Thornless blackberries need support but also have to be thinned; old canes should be removed each year. A grower can train first-year canes up two corners of the pyramid and second-year canes up the opposite two corners. Then he can work down each row and quickly remove second-year canes after their bearing season, leaving first-year canes undisturbed. By alternating canes in this manner year after year, pruning is simplified.

From his strawberry research, Swartz found that mulches which promote higher root temperature (clear and black plastic) increased the yields of first-year everbearing strawberry selections. As much as 1 ton of strawberries per acre was harvested each week between mid-July and mid-August. Fruit size decreased throughout the season, but fruit quality remained excellent, he says.

Insect Control

Scale insects are economically important pests of several fruit trees. They have hitchhiked into this country primarily from the Orient and are now distributed uniformly throughout the United States.

California has been using parasitic wasps to keep scale populations below damaging levels for several years, but the Northeast is way behind in biocontrol of scales, says John W. Neal, Jr., an entomologist with the Florist and Nursery Corps Laboratory at Beltsville.

To rectify this situation, Neal is identifying potential biocontrol agents for three species of scale pests—the white peach scale, the San Jose scale, and the euonymus scale. Working in cooperation with the University of Maryland, Neal must first identify the species and distribution of native wasps that parasitize the scales. Later, he and cooperators plan to introduce and test Oriental wasps as potential biocontrol agents of these scale insects.

The white peach scale attacks peaches and cherries, including the ornamental Kwanson cherry, as well as privet. San Jose scale is a pest of apples and other pomaceous fruits; and euonymus scale attacks the ground cover pachysandra as well as the ornamental shrub it is named after.

The cost of fuel and its direct effect on shipping costs could influence the share of fruits and vegetables marketed in the Northeast that would be produced on family farms there. Findings from all the projects involved in the ARS research effort should increase the contribution of family farms to northeastern markets and should enhance the ability of family farms to compete in those markets.

Researchers Cantelo, Chaney, Hornick, Kerr, Lewis, Lumsden, Millner, Neal, Nickle, Sayre, Stoner, Teasdale, and Thomas are located at the Beltsville Agricultural Research Center, Beltsville, MD 20705. Franklin D. Schales is located at the University of Maryland, Vegetable Research Farm, Route 5, Salisbury, MD 21801. Harry Swartz' address is Department of Horticulture, University of Maryland, College Park, MD 20742.—(By Judy McBride, ARS, Beltsville Md.)

A Clonal Repository

A national effort to perserve the genetic material of fruits and nuts became a reality this spring with the dedication of the Northwest Plant Germplasm Repository (NWPGR) in Corvallis, Ore., in April. This is the first national repository specifically designed to collect, preserve, and distribute germplasm of plants that are cloned or vegetatively propagated.

Plant breeders usually use the germplasm contained in seed to pass specific genetic characteristics on to new plant varieties. To aid in this work, USDA has for many years maintained seed repositories across the country.

Many perennial crops such as fruits and nuts, however, have inheritance patterns too complex to be duplicated from seed. These crops must be propagated through clonal or vegetative methods, and their germplasm must be preserved in living plants.

The NWPGR is the first of the 12 proposed colonal repositories to be located at ARS facilities or State Agricultural Experiment Stations where specific germplasm collections are likely to survive local environments. Built at a cost of $1.8 million, the NWPGR will house germplasm collections of small fruits including strawberries, raspberries, and blackberries. It will also maintain collections of pears, filberts, hops, and mint.

Two or three plants of each collection will be maintained in one of six greenhouses or in screenhouses. Pears and filberts will also be grown outside. With supplemental field areas, the NWPGR is expected to eventually maintain several thousand collections.

When the collections are established, rootstock, cuttings, pollen, or whatever material is needed for plant breeding will be sent on request. Breeders who use material must report their findings back to the Repository so that information can be made available to others who need it. They must also acknowledge the NWPGR as the source of germplasm in any publications.

ARS horticulturist Otto Jahn is the curator of the Repository. He will work with Mel Westwood, a horticulturist with Oregon State University, and a support staff of technicians and aids, currently being hired. OSU is cooperating with ARS in the operation of the NWPGR.

Jahn says that new collections will come from all over the world. Information on disease and insect resistance will be recorded and collections will then be grafted and grown out to verify this resistance.

It will be at least a year, says Jahn, before stock collections at the NWPGR are sufficiently built up to begin granting requests for germplasm.

Dr. Jahn is located at the Northwest Plant Germplasm Repository, 33447 Peoria Road, Corvallis, OR. 97330. —(By Lynn Yarris, ARS, Oakland, Calif.)

Breeding Line 1 Herefords

The place was the annual cattle sale held at ARS's Livestock and Range Research Station, Miles City, Mont. There a 3-year-old Line 1 Hereford bull sold for $160,000—the highest price ever paid for a single animal in the history of the sale.

In all, 63 bulls of various lines were sold for about $353,000 to buyers from throughout the United States and Canada. Money received from the sale is used for the station's operations.

The sale price of Line 1 Herefords averaged $10,565 per head, more than five times the $1,911 average price brought in by all other lines of Herefords.

The Line 1 program was first established at the Miles City Station in 1934 and is one of the longest continuing beef cattle line-breeding programs in the United States. The animals have been maintained as a closed herd with no introduction of bulls or cows from other herds.

Line 1 Herefords have developed into sound Hereford cattle with good conformation and meat quality and a fast growth rate. Weaning weight and yearling weight are increasing by 22 and 35 pounds, respectively, per generation (about every 4 years); this is the most rapid and consistent gain in average weaning and yearling weight of any of the Hereford varieties.

Despite coming into industry prominence only within the past decade, Line 1 Herefords already command the Nation's highest average sale price for breeder bulls. Currently, almost half of the registered Hereford breeders in the country have cattle from or descended from the Miles City Line 1 herd, even though the herd has never numbered over 150 calving cows.

Animal physiologist Robert A. Bellows is the current research leader at the Station. His address is ARS Livestock and Range Research Station, Route 1, Box 3, Miles City, MT 59301—(By Lynn Yarris, ARS, Oakland, Calif.)

A Potential Ally for Corn Producers

A pathogenic protozoan, *Nosema pyrausta,* may become an ally of corn producers in their war against the European corn borer.

"N. pyrausta is the most effective naturally occurring pathogen of the European corn borer," says Leslie C. Lewis, research entomologist at the ARS Corn Insects Research Laboratory, Ankeny, Iowa.

Lewis and his colleagues found, in one experiment, that *N. pyrausta* reduced the number of corn borer larvae per corn plant by 48 percent. In another similar test, 99 percent of the larvae collected from the treated plants were infected with *N. pyrausta.*

Lewis is trying to find better ways to mass produce, store, and apply the organism so that it can become a practical weapon against the corn borer.

"The disease causes chronic and debilitating effects on the corn borer's health. It retards feeding activity and growth of the larvae, and reduces the insect's life span, the sex drive of the male, and the number of eggs the female produces," Lewis says.

Because *N. pyrausta* requires a living host, it can be produced only in corn borers or some other susceptible insect larvae. Lewis grinds the infected larvae, mixes a water solution, and sprays the material on the corn. He has developed techniques to keep vacuum-dried spores for as long as 18 months.

The disease has an increasing potential for suppression of the borer population if folier applications are made on the first gereration of borers. Because the pathogen is passed on through the eggs, it spreads more widely with each generation. The disease is also spread by the excretions of diseased larvae that carry *N. pyrausta* to adjacent plants when they move from one corn stalk to another.

N. pyrausta is most effective in combination with other stresses such as insecticide treatment, bad weather, or other disease organisms, Lewis says.

"In our experiments, all insecticide treatments in combination with *N. pyrausta* had significantly greater percentages of larval mortality than did *N. pyrausta* used alone," he says. "Tests were made with three materials, carbaryl and carbofuran, both carbamate insecticides, and *Bacillus thuringiensis,* a bacterial insecticide."

A pathogenic protozoan may become a practical weapon against this corn borer larva and its cohorts. (Photo courtesy of Grant Heilman.)

The addition of *N. pyrausta* to other insecticides decreased larvae numbers per plant an average of 39 percent in the first generation of borers, Lewis says. Stalk cavity counts in the same experiments showed the addition of *N. pyrausta* on plants infested with borers reduced cavities an average of 38 percent.

Lewis suggests that the corn borer can tolerate *N. pyrausta* under ideal conditions though its feeding and growth rate will be reduced, resulting in less damage to the corn crop. But, if another stress factor is introduced, the corn borer population will be substantially depressed.

Working with Lewis on the studies were Robert E. Lynch, an ARS research entomologist now stationed at USDA's Southern Grain Insects Research Laboratory, Tifton, GA, and graduate student John Lublinkhof.—(By Ray Pierce, ARS, Peoria, Ill.)

Hot-Callusing for Grafting Dormant Filbert Trees

A breakthrough in filbert propagation by ARS scientists should significantly increase the number of new trees produced each year and substantially reduce the time required for new varieties to be introduced and made available commercially.

A new device developed by ARS horticulturist Harry B. Lagerstedt, Corvallis, Or., makes grafting filbert trees easier by localizing thermostatically controlled hot air at the graft union to accelerate the growth of callus tissue.

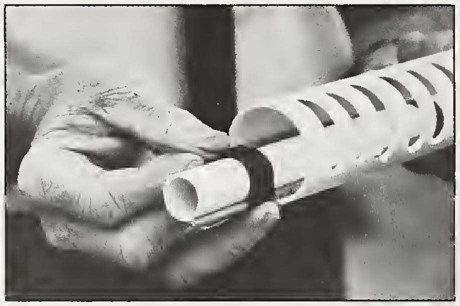
Production of filberts, or hazel nuts as they are called in the East, is a growing industry in the Pacific Northwest. Production had expanded from only 300 tons in 1930 to more than 14,000 tons in 1980 valued at nearly $17 million.

The industry might have expanded more rapidly except for the difficulty of quickly increasing the numbers of filbert plants. Layerage, the technique of rooting a growing stem that is bent into the ground while still attached to the parent plant, has long been the only means available for filbert propagation.

Although layerage produces plants large enough to go directly from a nursery to an orchard in their first season, only one new plant a year can be produced from each layered stem of the parent plant. Using layerage, nurseries need 5 to 8 years to build up a sufficient stock of new varieties for commercial sales. Also, trees propagated on their own root systems by layerage develop suckers that pose lifelong orchard management problems.

Early attempts at grafting filbert trees produced only a 10 percent success rate. Then it was discovered that filberts require temperatures of at least 70°F for graft unions to callus. Subjecting entire plants to 70°F, however, requires expensive greenhouse space. In addition, scion buds respond to the warm temperatures and begin growing too soon. Greenhouse grafting works, but trees must be potted and tended for several months thereafter.

Lagerstedt's hot-callusing device avoids these problems. When used out-



Top left: Plastic hot callusing pipe consists of two cylinders. The outer cylinder is slotted to localize warm air to graft unions while holding them in place. The inner cylinder separates two heating cables and helps stabilize air temperature when filled with water (0381X318-24).

Top right: These whip and tongue grafts were callused following 28 days on the hot-callusing device at 80 degrees F. Graft unions are bound with rubber grafting bands (0381X318-12a).

Opposite bottom: Harry Lagerstedt, ARS horticulturist who designed this device, examines filbert trees during hot-callusing process. After they have been grafted, rootstocks, left, and scions, right, are layed across pipe at the point of the union. Sawdust, left, keeps root systems moist while heat from the pipe speeds up callus development. Foam pad that covers graft union helps retain heat in the pipe (0381X317-33).

Above: After grafts are completed, Lagerstedt "heels them in"—puts them in sawdust—until they are placed in cold storage or planted in the nursery (0381X317-25).

doors during late winter and early spring, it surrounds graft unions with heated air while scion buds are exposed to low air temperatures. This accelerates callusing at the union while allowing buds to remain in a dormant state.

At temperatures of 75°F to 80°F, the graft union is formed in about 3 weeks. Trees can then be planted in the nursery. When the buds break dormancy in the spring, the trees grow with good success because the union is already formed.

The device Lagerstedt designed consists of a 2-inch plastic pipe into which ½-inch slots have been cut perpendicular to the length of the pipe. A smaller, ½-inch plastic pipe, filled with water and separating a pair of heating cables running parallel with it, passes through the larger pipe. Graft unions (Largerstedt uses a whip and tongue graft) are placed along the 2-inch pipe, in the slots, and covered with a 4-inch-wide foam rubber strip to retard the escape of air warmed by the heating cable. Root systems of the rootstocks are covered with sawdust to keep them moist.

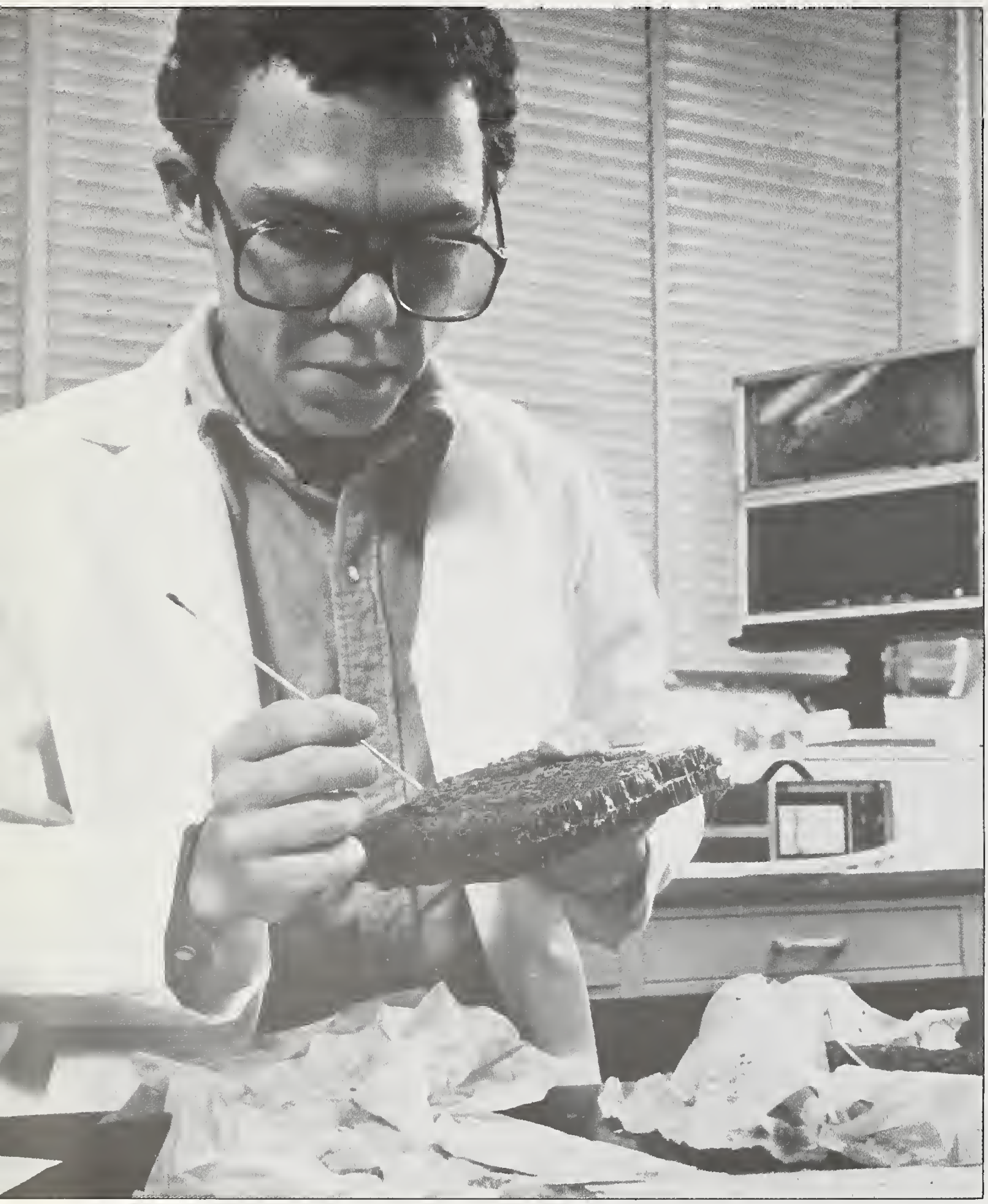
Lagerstedt's grafting success averaged over 90 percent following hot-callusing. With a 21- to 28-day callusing period, one device could handle as many as 4 cycles of grafted unions during a dormant season. An 85-foot-long hot-callusing pipe would be capable of accommodating 1,000 graft unions at a time, which means it could produce at least 4,000 new trees each dormant season.

Requiring no protective structure and being relatively trouble-free, the device is very inexpensive compared with the cost of greenhouse propagation. It can be laid out on bare ground or gravel and requires only a source of electricity to operate the heating cable. Because the device is used during the dormant season, it allows nursery owners to efficiently utilize their work force all year. Although hot-callusing was developed for filbert trees, apple, pear, peach, and plum trees have also been successfully hot-callused.

Unlike the filbert trees produced by layerage, grafted hot-callused trees must be grown in the nursery for a year before they are large enough to cope with orchard conditions. The overwhelming advantage in increased numbers of trees, however, should more than compensate for the extra growing time in the nursery.

Dr. Lagerstedt is located at Rm. 1034, Cordley Hall, Oregon State University, Corvallis, OR 97331.—(By Lynn Yarris, ARS, Oakland, Calif.)

Beltsville "Bee Doctors" Run Diagnostic Clinic



There's a diagnostic service in Beltsville that's not for your car or your body. It's for sick honey bees.

Nearly 2,000 times a year, scientists at the ARS Bioenvironmental Bee Laboratory diagnose samples of sick bees or disease-infected honeycombs mailed in by beekeepers and apiary inspectors.

This service helps maintain the health of the Nation's honey bees, which are vital to agriculture. Without honey bees for pollination, considerably fewer fruits and vegetables would reach market, and nearly all food, including meat, would be more expensive.

Any industry with an annual investment in goods and services of $12 to 15 billion—the total value of crops pollinated by honey bees—would want to keep a healthy labor force. And so it is with beekeeping.

The "bee doctors" of Beltsville's diagnostic service verify the opinions of bee inspectors at state departments of agriculture or of beekeepers themselves. These entomologists first examine a mailed-in specimen under a microscope. They look for spores of the microorganisms that cause American foulbrood disease, chalkboard disease, sacbrook, paralysis disease, and other bee maladies. The scientists also check for symptoms of parasites such as bee "lice," mites, and the larvae of the greater wax moth, which can transform the neat geometry of a honey comb into an unrecognizable mess.

When a disease is found, word is sent to the beekeeper and to the chief apiary inspector of his or her state, who check to make sure that the beekeeper treats the tainted colonies immediately.

At the lab, leftover disease samples are studied to determine if the disease germs in certain geographical areas have developed resistance to the antibiotics that beekeepers depend on to keep their operations healthy.

Above: Just as honey bees work to keep crops pollinated for agriculture, ARS scientists are working at a special diagnostic lab in Beltsville, Md., to help keep bees healthy. John Willinger, biological aide and University of Maryland student, examines honeycomb for dead larvae, an indication of brood disease (0481W362-6).

Right: Beekeepers and apiary inspectors send samples of infected bees and honeycombs to the lab for diagnosis (0481W363-8).

Samples of diseases or dead bees come to the Beltsville lab from many parts of the country. Thus, the diagnostic service helps entomologists know the distribution of bee diseases. Laboratory chief Hachiro Shimanuki says the service could provide early warning if a serious disease appears to be spreading or if a potentially disastrous foreign disease has entered the country.

Diseases and parasites cost the beekeeping industry millions of dollars each year with the loss of bees and bee equipment. The public also pays a price with the loss of pollination services and the need for inspection services. The cost would undoubtedly be higher without the ARS diagnostic service of Beltsville.

Dr. Hachiro Shimanuki is located at Bioenvironmental Bee Laboratory, Rm. 208. Bldg. 476, Beltsville, MD 20705.—(By Steve Berberich, ARS, Beltsville, Md.)

Above left: An ounce of prevention is worth a pound of baking soda. To lessen the chance of a sting, Willinger repels bees with a smoke screen before examining combs (0481W363-15).

Above: By dousing a sample of bees and then examining the drain water under a microscope, Mercedes Delfinado-Baker, mite specialist, left, and Hachiro Shimanuki, lab chief, can determine if the colony is infested with mites (0481W361-33a).

Left: Even a smoke screen couldn't drive these bees from their hive. Willinger exhibits one of the labs own combs used for study (0481W363-27).

U.S. Government Printing Office
Public Documents Department
Washington, D.C. 20402
Official Business

Postage and Fees Paid
U.S. Department
of Agriculture

G-95

Agrisearch Notes

CONSERVATION TILLAGE REDUCES EROSION BUT NOT YIELDS No-till corn can be grown in the Southern Mississippi Valley Silty Uplands with minimal erosion and good crop yields, according to ARS agricultural engineer K. C. McGregor and hydraulic engineering technician Jackie D. Greer. The soils in this land resource area are highly erodible, but farmers are often reluctant to adopt conservation tillage because they fear that yields will go down.

Three years of tests at the Southern Mississippi Valley Silty Uplands land resource area show that erosion plots and small watersheds planted to no-till and reduced-till corn for grain or silage sustained consistently low rates of erosion. Crop yields from both no-till and reduced-till treatments, however, compared favorably with yields from conventionally tilled plots.

For example, the average annual soil loss from erosion plots in conventinally tilled corn for grain was about 22 times greater than that from plots in no-till corn for grain.

McGregor and Greer report that runoff from these conservation-tilled areas was also significantly lower than from the conventionally tilled areas. Runoff from no-till and reduced-till grain plots was 12 and 45 percent less, respectively, than runoff from conventionally tilled grain plots. The surprisingly low runoff and soil loss rates from the reduced-till treatments indicated that corn can be cultivated during the early part of the growing season without excessive erosion.

The 3-year average corn yield for conventionally tilled grain was 7,490 kg/ha. The no-till corn yield 7,550 kg/ha, and the reduced-till corn yield 8,340 kg/ha.

Keith C. McGregor and Jackie D. Greer are located at the USDA Sedimentation Laboratory, P.O. Box 1157, Oxford, MS 38655.—(By Neal Duncan, ARS, New Orleans, La.)

SWEET SORGHUM FOR LIQUID FUEL. Sweet sorghum could be a high-energy crop for the production of fuel alcohol. SEA agronomist Kelly C. Freeman says that sweet sorghum, which has wide adaptability within the United States and many other parts of the world, could yield 500 to 800 gallons of alcohol per acre.

Alcohol, as a liquid fuel produced from sweet sorghum and other carbohydrate crops, could help reduce oil imports and thus reduce our foreign trade deficit by supplementing domestic energy sources.

By-products of the crop such as distillers dried grain and fertilizer could provide additional income. The grain itself could be sold for uses other than the production of fuel alcohol because it provides for only about 5 percent of the alcohol production. Sugars in the stalks of sweet sorghum provide about 80 percent of the alcohol and those in the stalk fibers about 15 percent.

Freeman envisions sweet sorghum being distilled for about 3 months of each year. During the remainder of the year, other feedstocks such as wood by-products and recycled paper, surplus grain, molasses, and surplus or damaged vegetables could be used.

Kelly C. Freeman is located at the U.S. Sugar Crops Field Station, Route 10, Box 152, Meridian, MS 39503.—(By Bennett Carriere, SEA, New Orleans, La.)